CLAIMS

What is claimed is:

1. An active optical filter comprising:

a filter input component disposed to receive an optical input signal;

a filter output component disposed to provide a filtered output signal;

an optical amplifier;

at least one optical delay element;

a surface grating coupler positioned between said optical amplifier and each of said delay elements to form a first light transmission path, said first light transmission path having an end coupled to said filter input component and another end coupled to said filter output component; and

a second light transmission path disposed to transmit optical signals without delay from said filter input component to said filter output component.

2. The optical filter of Claim 1, wherein:

said first light transmission path has an input end coupled to said filter output component, and an output end coupled to said filter input component, to produce a filtered output signal comprising an infinite pulse response (IIR) when an optical pulse is applied as an input signal to said filter input component.

3. The optical filter of Claim 2, wherein:

said first light transmission path includes a first surface grating coupler and a first delay element positioned between the input side of said optical amplifier and said filter output component, and a second surface grating coupler and a second delay element positioned between the output side of said optical amplifier and said filter input component.

4. The optical filter of Claim 3, wherein:

said first light transmission path comprises multiple optical amplifiers, each having associated delay elements and surface grating couplers interconnected to form a filter of selected higher order.

5. The optical filter of Claim 1, wherein:

said first light transmission path has an input end coupled to said filter input component, and an output end coupled to said filter output component, to produce a filtered output signal comprising a finite impulse response (FIR) when an optical pulse is applied as an input signal to said filter input component.

6. The optical filter of Claim 5, wherein:

said first light transmission path includes a first surface grating coupler and a first delay element positioned between the input side of said optical amplifier and said filter input component, and a second surface grating coupler and a second delay element positioned between the output side of said optical amplifier and said filter output component.

7. The optical filter of Claim 6, wherein:

said first light transmission path comprises multiple optical amplifiers, each having associated delay elements and surface grating couplers interconnected to form a filter of selected higher order.

8. The optical filter of Claim 1, wherein:

each of said surface grating couplers comprises a grating surface emitter photonic integrated circuit.

9. The optical filter of Claim 1, wherein:

each of said surface grating couplers comprises a photonic crystal.

10. The optical filter of Claim 1, wherein:

each said surface grating couplers comprises a trench coupler.

11. The optical filter of Claim 1, wherein:

Said filter is turnable to transmit only optical signals of a specified frequency.

12. The optical filter of Claim 1, wherein:

said filter is programmable to transmit only optical signals lying in a passband of specified bandwidth.

13. An active optical lattice filter for selectively processing an optical input signal, said lattice filter comprising:

a plurality of optical gain blocks spaced apart from one another in a linear array;

a surface grating coupler positioned between each pair of adjacent gain blocks in said array, each of said surface grating couplers disposed to transmit a portion of an optical signal received as an input from one of its adjacent gain blocks to its other adjacent gain block, and to reflect the remainder of said received input; and

each of the gain blocks is provided with controllable gain and delay characteristics respectively selected to produce an output from said array comprising an IIR when said input signal comprises an optical pulse.

14. The active lattice filter of Claim 13, wherein:

said gain blocks are respectively implemented by placing electrodes in spaced apart relationship upon an active region of semiconductor material to form corresponding gain regions therein; and

each of said surface grating couplers comprises a grating formed in the surface of said active region between adjacent gain regions.

15. A 2-Dimensional lattice filter disposed to selectively process an input signal, said lattice filter comprising:

a plurality of delay blocks, each delay block disposed to receive, process and project specified signals, said delay blocks grouped into at least one filter section for said lattice filter; and

a plurality of 4 direction couplers, each 4 direction coupler being associated with delay blocks in at least one of said filter sections, each 4 direction coupler positioned to exchange specified signals directed along a first axis with one of its associated delay blocks, and to exchange specified signals directed along a second axis orthogonal to said first axis with another of its associated delay blocks.

16. The 2-Dimensional lattice filter of Claim 15, wherein:

said input signal comprises an optical signal pulse.

17. The 2-Dimensional lattice filter of Claim 16, wherein:

each of said 4 direction couplers has two pairs of faces, the faces of each pair being parallel to one of said first and second axes.

18. The 2-Dimensional lattice filter of Claim 16, wherein:

at least one of said delay blocks has a controllable gainfor selectively amplifying a signal coupled therethrough.

19. The 2-Dimensional lattice filters fo Claim 18, wherein:

said filter is disposed to operate as an active filter.

20. The 2-Dimensional lattice filter of Claim 19, wherein:

each of said 2D lattice couplers comprises a crossed grating coupler.

21. The 2-Dimensional lattice filter of Claim 19, wherein:

each of said direction couplers comprises a crossed beam splitter.

22. A 2-dimensional filter section comprising:

a plurality of delay blocks positioned around a closed loop in spaced apart relationship; and

a plurality of 4 direction couplers interspersed between said delay blocks to form a closed path for signal flow, each of said 4 direction couplers disposed to exchange specified signals with two adjacent delay blocks along first and second orthogonal axes, respectively.

23. The 2-Dimensional filter section of Claim 22, wherein:

said filter section is disposed to receive an input signal comprising an optical signal pulse.

24. The 2-Dimensional filter section of Claim 23, wherein:

at least one of said delay blocks has a controllable gain for selectively amplifying a signal coupled therethrough.

25. The 2-Dimensional filter section of Claim 24, wherein:

said filter section is disposed to operate as an active filter.

26. The 2-Dimensional filter section of Claim 25, wherein:

each of said 4 direction couplers comprises a crossed grating coupler.

27. The 2-Dimensional filter section of Claim 25, wherein:

each of said 4 direction couplers comprises a crossed beam splitter.

28. The 2-Dimensional filter section of Claim 22 wherein:

said filter section comprises a particular filter section of a higher order2-Dimensional lattice filter comprising multiple filter sections, each substantially identical to said particular filter section.

29. A 2-Dimensional filter stage comprising:

a linear array of 4 direction couplers positioned in spaced apart relationship along a first axis, each of said 4 direction couplers disposed to establish selected transmission paths for signals traveling along said first axis, and to establish other transmission paths for signals traveling along other axes that are respectively orthogonal to said first axis;

one or more first delay blocks, each positioned between two of said 4 direction couplers to selectively process signals traveling therebetween along said first axis; and

a plurality of second delay blocks, each positioned along one of said orthogonal axes to selectively process signals directed therealong by a corresponding one of said 4 direction couplers.

30. The 2-Dimensional filter stage of Claim 29, wherein:

said filter stage is disposed to receive an input signal comprising an optical signal pulse.

31. The 2-Dimensional filter stage of Claim 30, wherein:

at least one of said delay blocks has a controllable gain for selectively amplifying a signal coupled therethrough.

32. The 2-Dimensional filter stage of Claim 31, wherein:

said filter stage is disposed to operate as an active filter stage.

33. The 2-Dimensional filter stage of Claim 32, wherein:

each of said 4 direction couplers comprises a crossed grating coupler.

34. The 2-Dimensional filter stage of Claim 32, wherein:

each of said direction couplers comprises a crossed beam splitter.

35. The 2-Dimensional filter stage of Claim 29 wherein:

said filter stage comprises a particular filter stage of a higher order 2-Dimensional lattice filter comprising multiple filter stages, each substantially identical to said particular filter stage.

36. A 2-Dimensional filter stage comprising:

a linear array of multi-direction couplers positioned in spaced apart relationship along a first axis, each of said multi-direction couplers disposed to establish selected transmission paths for signals traveling along said first axis, and to establish other transmission paths for signals traveling along other axes with respect to said first axis;

one or more first delay blocks, each positioned between two of said milti-direction couplers to selectively process signals traveling therebetween along said first axis; and

a plurality of second delay blocks, each positioned along one of said other axes to selectively process signals directed therealong by a corresponding one of said multi-direction couplers.